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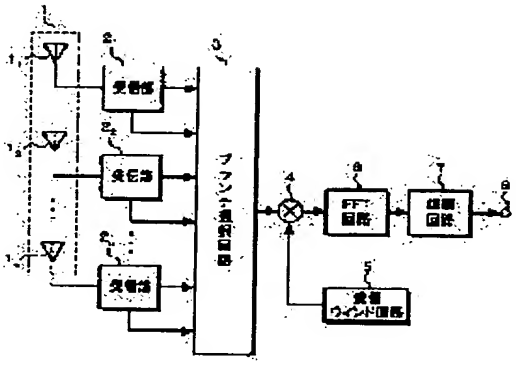
(54) DIVERSITY RECEIVER

(57)Abstract:
PROBLEM TO BE SOLVED: To prevent the effects of frequency fading from being given to the reception system of an OFDM communication system and also to reduce the circuit scale by controlling a branch selecting means in accordance with the output of a signal information detecting means.
SOLUTION: Signals from other terminals are received by unidirectional antennas 11,..., 1n whose respective directivities are turned in different directions so as to divide a space are into n parts. In respective receiving part 21,..., 2n, the receiving signals of the antennas are amplified, band limited. AGC-controlled and converted into an intermediate frequency signal. Receiving signal strength information of each receiving part is supplied to a branch selecting circuit 3. The circuit 3 changes over the outputs of the receiving parts based on receiving signal strength information of the whole band of respective branches. That is, the receiving signal strength of the band of the receiving parts as a whole is determined, and the signal of the branch with the largest receiving signal strength is selected.



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* NOTICES *

1. This document has been translated by computer.So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
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CLAIMS

[Claim(s)]
[Claim 1] In the diversity reception equipment which receives the data which were modulated primarily and modulated further secondarily Two or more unidirectional antennas which were turned in the mutually different direction and have been arranged, A signaling information detection means to detect the signaling information of the whole band of each input signal of two or more above-mentioned unidirectional antennas, A branch selection means to choose the input signal of each branch received with two or more above-mentioned unidirectional antennas, The recovery means of the secondary modulation which restores to a secondary modulation to the above-mentioned input signal chosen with the above-mentioned branch selection means, Diversity reception equipment which is equipped with the recovery means of the primary modulation which restores to a primary modulation to the output signal of the recovery means of the above-mentioned second modulation, and controlled the above-mentioned branch selection means according to the output of the above-mentioned signaling information detection means.
[Claim 2] The above-mentioned signaling information detection means is diversity reception equipment according to claim 1 which is what detects the signal strength of the whole band of an input signal.
[Claim 3] The above-mentioned signaling information detection means is diversity reception equipment according to claim 1 which is what detects the quality of an input signal.
[Claim 4] The above-mentioned signaling information detection means is diversity reception equipment according to claim 3 which is what detects the error rate of an input signal.
[Claim 5] The above-mentioned second modulation is diversity reception equipment according to claim 1 which is rectangular frequency multiplex system.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] This invention is used for communication system, such as high-speed wireless LAN (Local Area Network), and relates to suitable diversity reception equipment.
[0002]
[Description of the Prior Art] It is in office etc. and recent years are prosperous in LAN which connects mutually and employs information management systems, such as a computer, efficiently with a cable. Moreover, if it continues till present, the technology of the wireless LAN which achieves an equivalent function on radio also progresses, and is put in practical use. The transmission speed of the information on this wireless LAN is Number Mbps. They are dozens Mbps(es), in order to transmit multimedia data, such as a dynamic image, to real time in the future, although it is a grade. Examination of the above improvement in the speed is performed briskly.
[0003] Improvement in the speed or when wide-band-izing, one of the biggest problems is the influence of transmission distortion [in / a multiple-rays transmission line / for an informational transmission speed]. It is a well-known fact for phasing to occur and to degrade communication quality in the environment which the so-called multi-pass wave produces. By the case of high-speed transmission, the frequency-drift nature and the intersymbol interference of not only the influence of transmission distortion but phasing especially only pose a big problem. However the direction of these transmission distortion may serve as a dominant noise element from the internal noise of a receiving system and it may heighten transmitted power in connection with accelerating, it may lapse into the situation where communication quality is not improved. For this reason, in the high-speed radio-transmission system, a certain cure to propagation distortion etc. is made.
[0004] For example, using an OFDM (Orthogonal Frequency Division Multiplexing) method as one of the cures, such as transmission distortion in the high-speed transmission mentioned above, is proposed. This OFDM communication mode is one of the multi-carrier communication modes which divide a signal into some subcarriers and transmit it parallel on a frequency shaft, and is made possible [making a carrier interval into the minimum using a system of orthogonal functions, and making necessary bandwidth into a single carrier grade especially,].
[0005] In addition, FFT (Fast Fourier Transform) is used for the conversion and inverse transformation from the time-axis in an OFDM method to a frequency shaft, and it is not necessary to usually, have a modulator and demodulator in it for every subcarrier. Moreover, in the receive section which changes into an intermediate frequency signal the RF signal received by using FFT for the conversion and inverse transformation from a time-axis to a frequency shaft, it is supposed that it is possible to treat all carriers as one signal wave collectively.
[0006] Moreover, although the influence of an intersymbol interference can be dramatically lowered since a symbol period is elongated several times of a subcarrier when using an OFDM communication mode, this influence is nonavoidable as long as all carriers are being collectively treated to frequency-selective phasing.
[0007] For example, the influence of frequency-selective phasing in the case of a single carrier is shown in drawing 5 A, and the influence of frequency-selective phasing in the case of the multi-carrier obtained by drawing 5 B by OFDM-izing to the signal of drawing 5 A is shown. In addition, the horizontal axis in drawing 5 A and drawing 5 B shows frequency, and a vertical axis shows signal level.
[0008] As shown in drawing 5 B, even if the correlation in a band is high in the divided carrier unit, if it sees in all bands, correlation of the level between each carrier will be low, and will not escape the influence of frequency-selective phasing. [as well as the case of drawing 5 A] Thus, the influence of frequency-selective phasing is the biggest problem in an OFDM communication mode.
[0009] Since the problem in the OFDM communication mode mentioned above is coped with, the sub band assembled-die space diversity method is proposed (reference reference : an electronic-intelligence communication society paper magazine, Vol.J80-B- 2 No.6 pp.466-474 1997 June). This sub band assembled-die space diversity method divides the whole band into some sub bands, performs diversity composition processing for every band, and it is constituted so that the DIP by phasing on a frequency shaft or a time-axis may be removed.
[0010] For example, it has an antenna and three receiving systems, and the processing which chooses and compounds the high portion of the output level among each sub band which divides the whole band into five is explained using drawing 6 A, drawing 6 B, drawing 6 C, and drawing 6 D.
[0011] Drawing 6 A shows the band property of the sub bands a1-a5 formed of the 1st antenna and receiving system, drawing 6 B shows the band property of the sub bands b1-b5 formed of the 2nd antenna and receiving system, and drawing 6 C shows the band property of the sub bands c1-c5 formed of the 3rd antenna and receiving

system.
[0012] When diversity composition processing is performed to each output which has such a property As the high portion of an output level is chosen among each sub band of each channel and it is shown in drawing 6 D The sub bands c1 and c3 formed of the 3rd antenna and receiving system, The synthetic output from which the DIP portion which consists of sub bands b2 and b4 formed of the 2nd antenna and receiving system and a sub band a5 formed of the 1st antenna and receiving system was removed is formed.
[0013] By the way, generally, by high-speed transmission, since there is much amount of information per time, it is in the inclination for comparatively big transmitted power to be needed. For example, if it is going to obtain communication quality and a communications area equivalent to the case of low-speed transmission, only a part for amount of information to have doubled fundamentally must double transmission power.
[0014] However, the case where there is also a limitation of power consumption or a power amplification module, and attainment marginal distance (area which can be communicated) falls victim actually when generally is almost the case. Then, turning many independent antennas and receiving systems as one method of solving such a problem, and earning a fading margin is made.
[0015] For example, in the case where the number of independent antennas and receiving systems is expanded to 4 from 2, necessary 0.1% o'clock of fading margin of rates of hits decreases from 15dB to 7dB, and the effect same with having raised 8dB of transmitted power has this effect. Thus, while there is a property-advantage of changing many antenna **** receiving systems, the problem which an equipment scale increases and serves as a cost rise follows by changing much structurally. For this reason, when changing many antennas and receiving systems, it is thought appropriate to adopt the simplest selection composite system.
[0016] Drawing 7 shows an example of the diversity reception equipment of the OFDM communication mode which adopted the conventional sub band assembled-die space diversity mentioned above.
[0017] drawing 7 — setting — the antenna group 101 — n antennas 1011, 1012, and ... 101n It is constituted. these antennas 1011, 1012, and ... 101n For example, it considers as indirectional antennas, such as a whip antenna and a helical antenna, and is arranged in the place left spatially mutually.
[0018] an antenna 1011, 1012, and ... 101n The signal from the terminal of the other party is received. In addition, this signal modulates data primarily by QPSK (Quadrature Phase Shift Keying) or QAM (Quadrature Amplitude Modulation), and modulates them secondarily by the OFDM method further.
[0019] an antenna 1011, 1012, and ... 101n an output — a receive section 1021, 1022, and ... 102n It is alike, respectively and is supplied. a receive section 1021, 1022, and ... 102n respectively — a RF amplifying circuit, a frequency changing circuit, and AGC (Automatics Gain Contorol) It has a circuit etc.
[0020] a receive section 1021, 1022, and ... 102n respectively — alike — setting — each antenna 1011, 1012, and ... 101n It is amplified and band-limited, and an input signal is changed into an intermediate frequency signal, and AGC control is carried out. moreover, a receive section 1021, 1022, and ... 102n the control signal of an AGC circuit to each receive section 1021, 1022, and ... 102n Input-signal intensity is detected. each of this receive section 1021, 1022, and ... 102n input-signal intensity — a multiplier 1071, 1072, and ... 107n It is supplied.
[0021] a receive section 1021, 1022, and ... 102n an output — a multiplier 1031, 1032, and 1033...103n It is supplied, respectively. a multiplier 1031, 1032, and ... 103n respectively — being alike — the receiving window circuit 1041, 1042, and ... 104n The window signal from each is supplied. a multiplier 1031, 1032, and ... 103n It is alike, respectively, it sets, the time limit in an effective symbol period is prepared, and a predetermined portion is started.
[0022] a multiplier 1031, 1032, and ... 103n an output — the FFT circuit 1051, 1052, and ... 105n It is alike, respectively and is supplied. In each of the FFT circuit 1051, 1052, and ..., the parallel signal on a frequency shaft is changed into the serial signal on a time-axis, and recovery processing of OFDM is performed. these FFT circuits 1051 and 1052 and ... 105n Each output is supplied to the branch selection circuitry 108.
[0023] moreover, the FFT circuit 1051, 1052, and ... 105n an output — the received-power detector 1061, 1062, and ... 106n It is supplied, respectively. the received-power detector 1061, 1062, and ... 106n The input-signal intensity of each branch divided into the sub band is detected for every sub band. the received-power detector 1061, 1062, and ... 106n an output — a multiplier 1071, 1072, and ... 107n It is supplied. a multiplier 1071, 1072, and ... 107n An output is supplied to the branch selection circuitry 108.
[0024] The branch selection circuitry 108 measures the signal strength of each branch for every sub band, and chooses the signal of a branch with the highest level. namely, a receive section 1021, 1022, and ... 12n In each AGC circuit, the signal strength of the whole band of the input signal of each branch is detected. moreover, the received-power detector 1061, 1062, and ... 106n The input-signal intensity for every sub band of each branch is detected. The branch selection circuitry 108 switches each branch based on these.
[0025] The output of the branch selection circuitry 108 is supplied to a demodulator circuit 109. Recovery processing of primary modulations, such as QPSK and a QAM method, is performed by the demodulator circuit 109. The recovery output of a demodulator circuit 109 is taken out through an output terminal 110.
[0026] in addition, as the method of detection of the on-the-strength information for every sub band Although how to carry out direct detection of the on-the-strength information for every sub band using a filter with very high Q is also considered, are not realistic by the limitation of Q of a filter etc. Moreover, although how to carry out time-sharing detection by within a time [shorter than a phasing period] is also considered, since time is needed for a ******** and the operation of FFT from the first, the period of an OFDM symbol is not realistic in this case, and the method mentioned above is used for detection of on-the-strength information.
[0027]

[Problem(s) to be Solved by the Invention] However, in the conventional diversity reception equipment which applied the selection composite system to the receiving system of the OFDM communication mode which adopted the sub band assembled-die space diversity mentioned above, the receiving intensity for every sub band is detected by each branch, and the branch is switched. For this reason, it is necessary to establish the circuit for detecting the signal strength for every sub band in each branch. in order [namely,] to detect the intensity for every sub band in an above-mentioned example -- each branch -- the FFT circuit 1051, 1052, and ... 105n the received-power detector 1061, 1062, and ... 106n It is necessary to prepare. This serves as an obstacle of the miniaturization of equipment, and a cost cut.
[0028] Therefore, it is to offer the diversity reception equipment which enabled it to aim at curtailment of a circuit scale while making it the purpose of this invention not influenced of frequency phasing in the receiving system of an OFDM communication mode.
[0029]
[Means for Solving the Problem] In the diversity reception equipment which receives the data which this invention was modulated primarily and were further modulated secondarily in order to solve the above problem Two or more unidirectional antennas which were turned in the mutually different direction and have been arranged, A signaling information detection means to detect the signaling information of the whole band of each input signal of two or more unidirectional antennas, A branch selection means to choose the input signal of each branch received with two or more unidirectional antennas, The recovery means of the secondary modulation which restores to a secondary modulation to the input signal chosen with the branch selection means, It is diversity reception equipment which is equipped with the recovery means of the primary modulation which restores to a primary modulation to the output signal of the recovery means of the second modulation, and was equipped with the control means which control a branch selection means according to the output of a signaling information detection means.
[0030] In this invention, two or more unidirectional antennas which were turned in the mutually different direction and have been arranged are formed. By using a unidirectional antenna, arrival **** is separated and the phasing DIP itself becomes small. For this reason, a cost cut can be aimed at, while it becomes unnecessary to establish the detection means of the input-signal intensity for every sub band needed conventionally and a circuit scale is reduced.
[0031]
[Embodiments of the Invention] Hereafter, 1 operation gestalt of this invention is explained with reference to a drawing. Drawing 1 shows the whole 1 operation gestalt composition of this invention. In drawing 1 , 1 is an antenna group. the antenna group 1 -- n unidirectional antennas 11, 12, and ... 1n it constitutes -- having -- **** -- the unidirectional antenna 11, 12, and ... 1n An arrangement relation is turned in the direction in which each directivity differs, and is arranged so that n division of a space field may be done.
[0032] The example of installation in the case of using four unidirectional antennas as an example is shown in drawing 2 , and the directive property is shown in drawing 3 .
[0033] It is the unidirectional antenna 11, 12, 13, and 14 to the 4th page which becomes the flank of the cube-like base 10 as shown in drawing 2 . Each is attached. As a unidirectional antenna, Yagi Antenna, cross Yagi Antenna, and a parabolic antenna are used, for example. Therefore, a space field is the unidirectional antenna 11, as shown in drawing 3 . Directivity (the drawing solid line 31 shows) and unidirectional antenna 12 Directivity (the drawing solid line 32 shows) and unidirectional antenna 13 Directivity (the drawing solid line 33 shows) and unidirectional antenna 14 It is quadrisected by directivity (the drawing solid line 34 shows) at intervals of 90 degrees.
[0034] in addition, each antenna 11, 12, and ... 1n Neither a number nor arrangement composition is limited to ****. moreover, each antenna 11, 12, and ... 1n You may make it change the position arranged with a direction.
[0035] thus, the unidirectional antenna 11 which was turned in the direction in which each directivity differs so that n division of may be done to a space field, and has been arranged, 12, and ... 1n The signal from other terminals is received. Data are primarily modulated by QPSK or QAM and this signal is further modulated secondarily by the OFDM method. the unidirectional antenna 11, 12, and ... 1n a reception output -- a receive section 21, 22, and ... 2n It is alike, respectively and is supplied.
[0036] a receive section 21, 22, and ... 2n It has the RF amplifying circuit, the frequency changing circuit, and the AGC circuit, respectively. a receive section 21, 22, and ... 2n respectively -- alike -- setting -- each antenna 11, 12, and ... 1n AGC control is amplified, band-limited and carried out, and an input signal is changed into an intermediate frequency signal. this receive section 21, 22, and ... 2n An output is supplied to the branch selection circuitry 3.
[0037] moreover, a receive section 21, 22, and ... 2n For example, the input-signal on-the-strength information (RSSI) covering the whole receiving band of the input signal of each branch is acquired by the AGC circuit. each of this receive section 21, 22, and ... 2n Input-signal on-the-strength information is supplied to the branch selection circuitry 3.
[0038] the branch selection circuitry 3 -- the input-signal on-the-strength information on the whole band of an each branch -- being based -- a receive section 21, 22, and ... 2n An output is switched. namely, the branch selection circuitry 3 -- each receive section 21, 22, and ... 2n The input-signal intensity of the whole band is judged and the signal of a branch with the largest input-signal intensity is chosen.
[0039] The output of the branch selection circuitry 3 is supplied to a multiplier 4. Moreover, the window signal from the receiving window circuit 5 is supplied to a multiplier 4. In a multiplier 4, the time limit in an effective symbol period is prepared, and a predetermined portion is started.
[0040] The output of a multiplier 4 is supplied to the FFT circuit 6. In the FFT circuit 6, the parallel signal on a

frequency shaft is changed into the serial signal on a time-axis, and the recovery of OFDM is performed.
[0041] The output of the FFT circuit 6 is supplied to a demodulator circuit 7. In a demodulator circuit 7, recovery processing of primary modulations, such as QPSK and a QAM method, is performed. The recovery output of a demodulator circuit 7 is taken out through an output terminal 8.
[0042] 1 operation gestalt constituted as mentioned above -- the unidirectional antenna 11, 12, and ... 1n It is considering as the used directive branch composition, and frequency-selective phasing which is the trouble of an OFDM communication mode is suppressed. Suppression of this frequency-selective phasing is further explained to a detail.
[0043] The more this invention narrows the directivity of an antenna, the more It is made paying attention to the phenomenon (reference reference : an electronic-intelligence communication society paper magazine, Vol.J80-B- 2 No.6 pp.466-474 1997 June) of band internal phase Seki expansion of the narrow angle directional antenna that band internal phase Seki is expanded. In the case where the case where a nondirectional antenna is used, and a unidirectional antenna are used, a difference arises in correlation bandwidth. Furthermore, it explains, comparing the case of the space branch composition constituted from a conventional nondirectional antenna about this phenomenon with a case with the directive branch composition constituted from a unidirectional antenna of this application.
[0044] The conceptual diagram of space branch composition using the conventional nondirectional antenna is shown in drawing 4 A. Since it is indirectivity, arrival **** is making the phasing DIP shifted on a frequency shaft in this space branch, by arranging each antenna in a different position and considering as the spatial low correlation arrangement, although every branch will be received equally (to refer to drawing 4 A lower berth). Thus, it is almost ineffective by the wide band signal to make it act, although it is effective as a cure against phasing in the case of a narrow-band signal. For this reason, it will be necessary to carry out FFT of each reception output, to divide into a sub band, and to choose a band without a DIP.
[0045] On the other hand, the conceptual diagram of the directive branch composition of this application is shown in drawing 4 B. In a directive branch, since there is segregation of arrival ****, there is an operation which makes the phasing DIP itself small (refer to drawing 4 B lower berth). A disappearance operation of the phasing DIP in a directive branch is not perfect, and it is so possible that the effect is determined, the number of branches is increased and the directivity of an antenna simple substance becomes a narrow angle by relation between the number of arrival **** on real environment, and the branch number of partitions to make the effect increase.
[0046] Therefore, the directive division branch composition using the unidirectional antenna serves as the method of suppressing frequency-selective phasing which is the trouble of an OFDM communication mode with sub band division space diversity. Moreover, even if it can carry out remarkable reduction of the circuit needed for each branch, it will form many branches and it will obtain a fading margin if a selection composite system is used since what is necessary is for there to be no need of acquiring signal strength information for every sub band like conventional diversity reception equipment, and just to detect the signal strength of the whole band by each branch, a low power / low-cost-ization can be attained.
[0047] In addition, in explanation of 1 operation gestalt mentioned above, although the case where input-signal on-the-strength information was used as a criterion which carries out branch selection was explained instead, the error rate of the input signal in each branch etc. is good also as criteria of a selection judging of input-signal quality information. In this case, when there is an interference-noise wave from a visitor, the removal effect is added.
[0048] moreover, explanation of 1 operation form mentioned above -- setting -- a receive section 21, 22, and ... although the case where input-signal on-the-strength information was formed in the AGC circuit of the 2n last stage was explained, as input-signal on-the-strength information or ********** is formed in the stage before changing into an intermediate frequency signal and the circuit portion after intermediate frequency signal transformation is prepared in the next step of the branch selection circuitry 3, you may simplify a circuit further
[0049]
[Effect of the Invention] If it depends on this invention, while suppressing a circuit scale as much as possible to the receiving system of an OFDM communication mode, adopting a multi-branch selection composite system and suppressing transmission distortion, saving of transmitted power can be aimed at. Especially, if this invention is applied to domestic radio network SHITESUMU to which development is expected, it will become possible to offer SHITETEMU which has a low power/low cost from now on.

[Translation done.]